A Computer-Generated Reminder System Improves Physician Compliance with Diabetes Preventive Care Guidelines

David S. Nilasena MD, MSPH and Michael J. Lincoln MD

Department of Medicine, Salt Lake Veterans Affairs Medical Center
Department of Medical Informatics, University of Utah,
Salt Lake City, UT 84132

ABSTRACT

Computerized reminder systems have been shown to be effective in improving physician compliance with preventive services guidelines. Very little has been published about the use of computerized reminders for preventive care in diabetes. We implemented a computer-generated reminder system for diabetes care guidelines in a randomized controlled study in the outpatient clinics of 35 internal medicine residents at the University of Utah and Salt Lake Veterans Affairs Hospitals. After a six month study period, compliance with the recommended care significantly improved in both the intervention group that received patient-specific reminders about the guidelines (38.0% at baseline, 54.9% at follow-up) and the control group that received a nonspecific report (34.6% at baseline, 51.0% at follow-up). There was no significant difference between the two groups. Both clinic sites showed similar improvement over baseline levels of compliance. Residents who completed encounter forms used by the system showed a significantly greater improvement in compliance than those who did not complete encounter forms (19.7% vs. 7.6%, p=0.006). The improvements in guideline compliance were seen in all areas of diabetes preventive care studied, and significant improvements were seen with recommended items from the medical history, physical exam, laboratory testing, referrals, and patient education. The use of encounter forms by the providers significantly improved documented compliance with the guidelines in almost all categories of preventive care. These results suggest that computerized reminder systems improve compliance with recommended care more by facilitating the documentation of clinical findings and the ordering of recommended procedures than by providing the clinician with patient-specific information about guideline compliance status. Further study is needed to understand the implications of these findings to the development of future computerized reminder systems for chronic diseases such as diabetes.

INTRODUCTION

Computer-generated reminders have been shown to improve physician compliance with practice guidelines in a variety of clinical areas [1]. In the area of preventive care, there are many examples in which computerized reminder systems have been successful in improving guideline compliance [1-3]. In these systems, a computerized patient database is used along with the medical decision logic derived from selected practice guidelines to create reminders or prompts to physicians about the services recommended for each patient. Computerized reminder systems have been shown to improve rates of immunizations, cancer screening, and screening for hypercholesterolemia [1-3]. The computer-generated reminder intervention gives timely, patient-specific feedback to the provider about recommended services.

Diabetes mellitus (DM) is a chronic medical condition for which preventive services guidelines have been published and available for over ten years [4]. It has been noted that DM is a good prototype disease for the use of a computerized reminder system for several reasons [5]. DM is common, being present in over 11 million persons in the U.S., and it causes significant morbidity, mortality, and disability for diabetic patients because of its associated complications [6]. Guidelines for the care of diabetic patients have been published by the American Diabetes Association [ADA][3,7] and compliance with these guidelines could potentially reduce the complications of DM to a significant degree [6]. The level of guideline compliance has remained low following the publication and dissemination of the diabetes guidelines [8-9]. Similar results have been seen in guideline compliance studies for other conditions [10]. Finally, the complexity of the diabetes guidelines and the information needed to incorporate them into routine clinical practice is likely to be an important barrier to physicians which could be potentially overcome through the use of a computerized system [5,11].

There is only one previous study evaluating the effect of computerized reminders on DM care [5]. In that study, Lobach et. al. demonstrated a significant improvement in physician compliance with diabetes

0195-4210/95/$5.00

guidelines through the use of a Computer-Assisted Management Protocol (CAMP) which was incorporated into the TMR system [12] at Duke University. The overall compliance in the intervention (CAMP) group increased from 21% to 32% while the control group showed no improvement in compliance. The study utilized only eight recommendations, however, and it did not evaluate items from the medical history or patient education.

We have previously described the development and initial evaluation of a stand-alone, computerized reminder system for seven interrelated DM preventive care guidelines [11]. These DM guidelines encompass detailed information from the medical history, physical exam, laboratory, referrals, and patient education. In this paper, we report the results of a randomized controlled trial of that system in the outpatient clinics of internal medicine residents at our institution.

METHODS

The Computerized Reminder System

The description of the features and development of the computer-generated reminder system used in this study have been previously published [11]. Briefly, guidelines for preventive care in DM were selected from those published by the ADA [3,7] and from a review of the literature. The selected guidelines were organized into the following six categories:

- Renal care
- Foot care
- Eye care
- Glycemic control
- Macrovascular care
- Neurologic care

Each category was further divided into items performed at each routine visit and those recommended annually. A set of seven **encounter forms** was developed to capture clinical data to be used by the system. There were six annual patient evaluations forms and one routine visit encounter form. The seven forms together contained a total of 68 individual questions.

The DM guidelines and encounter forms were incorporated into a object-oriented C++ computer program that served as an longitudinal patient database for storing clinical data related to the DM guidelines. Baseline information about each patient from manual chart review and the responses to questions on any of the encounter forms are entered into the database via a graphical user interface with windows identical to the seven encounter forms.

The computer program outputs a printed paper **health maintenance (HM) report** for the patient's primary physician based on the currently available data for the patient. This report summarizes the patient's DM preventive-health status, and lists a schedule of upcoming or past due preventive-health activities for the patient. Clinical alerts about high-risk aspects of the patient's current profile are also presented. The report is placed at the front of the patient's chart so that the HM information is available to the physician at the next clinic visit by the patient.

Implementation of the Reminder System

1) Recruitment of participants. All internal medicine residents in the PGY2 or PGY3 year at the University of Utah were instructed about the content of the guidelines, the encounter forms to be used, and the process of using the reminder system. These residents see patients each week in a general internal medicine clinic at either University Hospital (UUMC) or the Veterans Affairs Medical Center (VAMC) in Salt Lake City. Thirty-five of the 36 residents consented to participate in the study which took place over a six month period between October 1993 and April 1994. Approval from the Institutional Review Boards at both clinic sites was obtained prior to the study.

2) Identification of diabetic patients. An attempt was made to identify all patients with DM at each site who was scheduled for a clinic visit with one of the participating resident physicians in the six months after the start of the project. The study included patients with a diagnosis of DM (Type I or II) who had been treated at one of the two sites within one year prior to the study. DM patients were identified by using clinic discharge ICD-9 CM codes, pharmacy records, and laboratory results with elevations in blood glucose or hemoglobin A1c. Non diabetic and newly diagnosed or diet-controlled DM patients and those receiving care at diabetes or endocrinology specialty clinics were excluded. Patients who did not keep their scheduled appointments and cases where the HM reports were not placed in the charts or where the charts were not available for review were also excluded.

3) Random assignment of resident physicians. Residents were randomly assigned to the intervention or control condition. Residents in the **intervention** group received the detailed patient-specific HM report at the time of their clinic visit with a DM patient. **Control** group residents received a blank report with the patient's name, ID number, and information about where to return encounter forms. Randomization was blocked by site (VAMC or UUMC) and by level of training (PGY2 or PGY3) to control for potential confounding. Both groups were given a complete set of blank encounter forms to complete as needed for each DM patient.

4) Data collection. For each DM patient identified, a manual review of the patient's hospital and clinic charts was performed by a physician (DSN) who abstracted all information that pertained to the guidelines used by the reminder system. The abstraction of baseline information included available records from a complete year prior to the start of the study. This information was then entered into the computerized database and an initial HM report about the patient was generated with suggestions for preventive services that were overdue or planned. For patients seen by residents in the control group, a generic report without specific recommendations was generated.

Labeled boxes were placed at each clinic site for the collection of completed encounter forms, and the residents in the study were given instructions on how to return the forms. For any patient with more than one visit during the study period, data from any completed encounter forms was entered into the computer database and an updated HM report was generated and placed in the patient's chart.

At the end of the study, the medical records of DM patients in the study were again reviewed and the relevant guideline information was abstracted in a manner similar to the baseline chart review. The information from this review and from any completed encounter forms was entered into the computer database to complete each patient's electronic record.

5) Compliance scores. The determination of physician compliance with the DM guidelines was calculated by dividing the number of items completed in accordance with the guidelines by the total number of items recommended for the patient. This number was expressed as a percent to give the **compliance score** between 0 and 100% for each patient. The baseline level of compliance was calculated using all data preceding the first clinic visit with a participating resident physician during the study period. The average compliance score of all patients seen by a resident was determined for each resident. Separate scores were calculated for each of the seven encounter form categories. Scores were also calculated separately for four **clinical categories**: medical history, physical exam, laboratory tests and referrals, and patient education.

6) Statistical analysis. A repeated measures ANOVA was performed using the change in compliance score from baseline to follow-up as the dependent variable. The independent variables included in the model were the clinic site (VAMC or UUMC), experimental condition (intervention or control), and use of encounter forms by the resident. A significance level of $p<0.01$ was used in the reporting of results.

RESULTS

DM patients

A total of 221 patient visits at the UUMC and 259 patient visits at the VAMC were initially identified for possible inclusion in the study. After exclusions were made, there were 47 DM patients at the UUMC and 117 patients at the VAMC available for analysis.

Compliance Scores

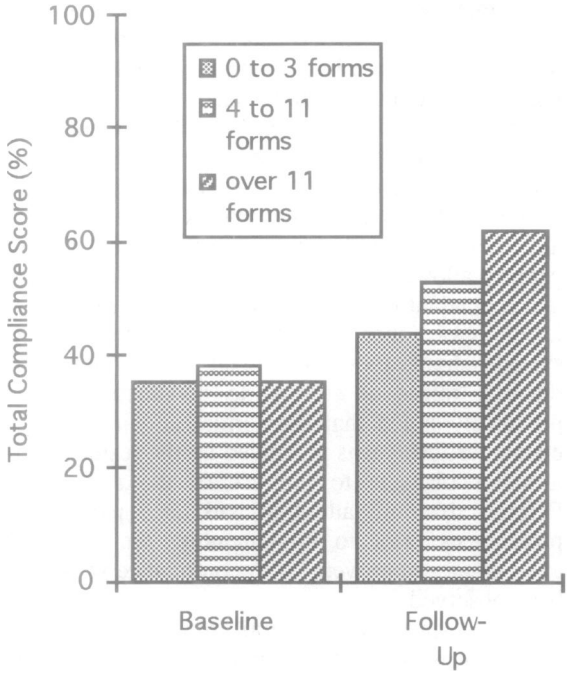
1) Total Compliance Scores. The average compliance score for all residents at baseline was 36.2% (Table 1). The overall change in total compliance score at one month after baseline was not significantly different from that at two, three, or four months after baseline, so the one-month follow-up interval was used for all subsequent analyses. The average compliance score for all residents at one-month follow-up was 52.8%, an increase of 16.6% over baseline ($F\ 1, 33= 110$, $p=0.0006$).

Table 1: Average Compliance Scores (%) for Residents at Baseline and One-Month Follow-Up, by Group, Site, and Use of Encounter Forms

	Baseline	Follow-Up	Change
All Residents	36.2	52.8	+16.6
Encounter Form Use			
Form Use	36.5	56.2	+19.7
No Form Use	35.6	43.2	+7.6
Clinic Site			
VAMC	36.5	49.8	+13.3
UUMC	36.0	56.1	+20.1
Group			
Intervention	38.0	54.9	+16.9
Control	34.6	51.0	+16.4

2) Compliance and Encounter Form Completion. One or more encounter forms were completed by 12 of 17 residents in the intervention group and by 14 of 18 residents in the control group. At baseline, the total compliance score of residents completing forms was not different from those not completing forms (36.5% vs. 35.6%). At follow-up, the improvement in compliance score was significantly higher in the group completing encounter forms than in the non completing group ($F\ 1,33= 8.5$, $p=0.006$). The number of encounter forms completed was directly related to the amount of improvement in compliance score (Figure 1). This finding was true for all seven encounter form categories and for all clinical categories except laboratory and referral.

Figure 1: Encounter Form Completion and Change in Compliance Score



3) Effect of Patient Specific Feedback on Compliance. The baseline compliance scores for the intervention group which received patient specific HM reports and for the control group were 38.0% and 34.6% respectively (Table 1). Both groups showed a significant improvement in compliance score at follow-up ($F_{1,18}$= 52, p=0.0001), however, there was no significant difference between the two groups in the change in compliance scores. This finding was true across all encounter form categories and all clinical categories.

4) Comparison by Clinic Site. The total compliance scores at baseline were similar for residents at the VAMC and UUMC clinics (Table 1). The overall change in compliance score at follow-up was significantly greater for the UUMC residents, however, after controlling for differences in the rate of encounter form completion, there was no significant difference in the improvement in compliance between the two sites.

5) Compliance Scores in Clinical Categories. Table 2 shows average compliance scores of residents broken down by clinical category and encounter form category. The highest compliance scores were seen in the Lab/Referral category while the lowest compliance score was in the Patient Education category. Improvement in compliance scores from baseline to follow-up were seen in all categories and were highest in the History and Routine Visit categories.

Table 2: Average Compliance Scores (%) for Residents at Baseline and One-Month Follow-Up, by Category

	Baseline	Follow-Up	Change
Encounter Form Items			
Eye Care	45.0	53.3	+8.3
Foot Care	41.0	52.5	+11.5
Glycemic Control	33.8	45.7	+11.9
Macrovascular	59.8	66.2	+6.4
Neurologic	17.9	34.4	+16.5
Renal Care	42.0	55.1	+13.1
Routine Visit	27.8	63.8	+36.0
Clinical Items			
History	33.3	55.2	+21.9
Physical	47.0	62.8	+15.8
Lab/Referral	67.3	76.8	+9.5
Pt. Education	6.4	18.6	+12.2

DISCUSSION

In this study, we implemented a computer-generated reminder system for diabetes preventive care in a randomized controlled trial in the outpatient clinics of thirty-five internal medicine residents. We found significantly improved compliance scores above baseline levels after the system was implemented. These improvements were seen in all categories of diabetic preventive care studied. The increase in compliance scores was the same in residents who received patient specific HM reminders and those who received a generic reminder. The improvement in documented compliance was significantly greater for residents who completed encounter forms than for those who did not, and the greater improvement was related to the number of encounter forms completed.

The average total compliance score for residents in the study increased by 16.6% after the reminder system was implemented. This amount of improvement in compliance is similar to that observed with other reminder systems and is comparable to the 11% increase that Lobach observed with the use of CAMP [5]. The improvements in compliance were seen within one month of the patients' clinic visits and did not show significant additional increases with longer follow-up

periods. This is understandable since the majority of the guideline indicators used by the system were items that are normally performed either during the clinic visit (history, physical, patient education) or shortly thereafter (lab tests and referral appointments).

The lack of difference in compliance change between the intervention and control groups was unexpected. We originally hypothesized that the patient-specific feedback that was present on the HM reports received by the intervention group would be an important reminder that would allow them to improve their guideline compliance. In fact, most residents thought the HM reports provided useful information and over a third thought the HM reports led to a change in their patient management [11]. The control group did not receive this feedback, however, and it showed an equivalent improvement in compliance score. There are several possible explanation for this.

First, the mere fact that both groups were involved in a closely monitored study may have altered their normal behavior (the "Hawthorne effect"). If this effect was strong, it could mask any additional compliance change that was due to the patient-specific feedback in the HM reports.

A second possibility is that there was a contamination effect between the groups since both intervention and control residents worked in the same clinics and any change in the intervention residents may have "spilled over" to affect the control group. The effect of the clinic attendings could also have contributed to this contamination [3], since they interacted with both groups of residents in the clinics. The attendings serve as opinion leaders for the residents and thus may have strong influences on their behavior [10].

The generic reminders about the patient's diabetes condition may have been sufficient to prompt a behavior change in the control residents. In addition, the availability of blank encounter forms in both groups could have served as a template of recommended care that caused equivalent reminder effects on both groups.

Recently, it has been reported that providing patient-specific information to physicians in the absence of direct human contact was insufficient to alter their patient care [13]. This may further explain why there was no additional improvement in compliance in the group receiving the HM reports.

The significantly greater improvements in compliance among the residents that completed encounter forms was an important finding of this study. The fact that both form users and form non-users had similar compliance at baseline argues against confounding by resident attitude or performance level (i.e. that the "good" residents in diabetic patient care are also "good" at completing encounter forms). This may indicate that the encounter forms facilitated either the performance or documentation of performance of recommended guideline items. Either of these effects are important to the improved care of diabetic patients. If the recommended items were not previously being done, the encounter forms may have assisted the physician in doing them both by serving as a reminder and by making the items easier to accomplish by focusing the physician's attention on the relevant items from the history, physical, lab, etc. If the recommended care was being done but was not documented, the encounter forms could facilitate that documentation and thereby provide the opportunity for improved care by allowing the avoidance of "overcompliance" and redundant care that may not be indicated. If this is the case, then the design of future reminder systems should focus on the end users' preferences in creating forms or screens to document care. We previously noted that the format and length of the encounter forms was perceived by the residents to be a major obstacle to the use of the system [11]. Perhaps, if more attention had been paid to user preferences prior to implementing the system, an even greater improvement in compliance would have been observed.

This study had several important limitations. First, it was conducted over a short study period of only six month. Since many of the diabetes guideline items are recommended on an annual basis, our study may have underestimated the real compliance levels that would have resulted from ongoing use of the system over a longer period. While others have noted that the success of reminder systems is dependent on man factors such as physician attitude and influence of attending physicians [3], it is possible that with repeated use of the system over several visits, even higher levels of documented compliance could have resulted, especially for residents who used the encounter forms.

Since "overcompliance", i.e. the ordering of excessive repeat tests or performing redundant exams, is difficult to assess without detailed knowledge of the patient's condition, we cannot determine whether the specific feedback led to more discriminating preventive care in the intervention group. It may be that because of the previously mentioned influences, a "shotgun" approach to guideline compliance was adopted and that the observed improvements in both groups were the result of residents doing all items at every visit whether or not it was indicated for the patient.

The extrapolation of our results to other settings may not be appropriate. This study was conducted in an academic medical center among physicians in training in a setting where diabetes preventive care and the adoption of practice guidelines are strongly endorsed. In other academic institutions without

strong advocates for the diabetes guidelines we used, and in practice settings in the community with more experienced physicians, the overall level of compliance and the effect of a computerized reminder system may be higher or lower, depending on the attitudes and experience of the physicians.

Our study did not examine the long term impact on outcomes in diabetic patients. As with many evaluative studies of computerized decision-support systems, the focus in our study was on process measures derived from established guidelines of care. Since most of the important clinical outcomes of diabetes take years to develop, we are restricted to trying to improve the processes of care for which there is some evidence of improved outcome. The results of the Diabetes Control and Complications Trial support the published ADA guidelines used in this study [14].

CONCLUSION

In this study, we found that a computer-generated reminder system can improve physician compliance with established guidelines for diabetes preventive care. This improvement may result from the ability of the system to facilitate physician documentation of important care items more than from the patient-specific feedback provided by the system. Future reminder systems may use patient-specific data to identify the appropriate documentation tools that need to be presented to providers in order to enhance their patient care. The evolving electronic medical record will greatly enhance reminder systems such as ours by making pertinent patient information continuously available to drive the system.

References

1. McDonald CJ, Hui SL, Smith DM, et. al. Reminders to physicians from an introspective computer medical record. A two year randomized trial. Ann Intern Med. 1984; 100: 130-8.

2. Ornstein SM, Garr DR, Jenkins RG, et. al. Computer-generated physician and patient reminders. Tools to improve population adherence to selected preventive services. J Fam Pract. 1991; 32: 82-90.

3. Tape TG, Campbell JR. Computerized Medical Records and Preventive Health Care: Success Depends On Many Factors. Am J Med. 1993; 94:619-25.

4. Rifkin H., ed. The Physician's Guide to Type II Diabetes (NIDDM). Diagnosis and Treatment. Alexandria, VA. American Diabetes Assoc., 1984.

5. Lobach DF, Hammond WE. Development and Evaluation of a Computer-Assisted Management Protocol (CAMP): Improved Compliance with Care Guidelines for Diabetes Mellitus. Proc Symp Comp Appl Med Care. 1994; 787-91.

6. Anderson RM. The challenge of translating scientific knowledge into improved diabetes care in the 1990s. Diabetes Care. 1991; 14: 418-21.

7. Clinical practice recommendations. American Diabetes Association 1990-1991. Diabetes-Care. 1991; 14 Suppl 2: 1-81.

8. Jacques CHM, Jones RL, Houts P, et. al. Reported practice behaviors for medical care of patients with diabetes mellitus by primary-care physicians in Pennsylvania. Diabetes Care. 1991; 14: 712-7.

9. Deeb LC, Pettijohn FP, Shirah JK, Freeman G. Interventions among primary-care practitioners to improve care for preventable complications of diabetes. Diabetes Care. 1988; 11: 275-80.

10. Lomas J, Enkin M, Anderson GM, et. al. Opinion leaders vs. audit and feedback to implement practice guidelines. JAMA. 1991; 265: 2202-7.

11. Nilasena DS, Lincoln ML, Turner CW, et. al. Development and Implementation of a Computer-Generated Reminder System for Diabetes Preventive Care. Proc Symp Comp Appl Med Care. 1994; 831-5.

12. Stead WW, Hammond WE. Computer-based Medical Records: the Centerpiece of TMR. MD Comput 1988; 5:48-62.

13. Lee TH, Pearson SD, Johnson PA, et. al. Failure of Information as an Intervention to Modify Clinical Management. Ann Intern Med. 1995; 122:434-7.

14. Harris MI, Eastman RC, Siebert C. The DCCT and Medical Care for Diabetes in the U.S. Diabetes Care. 1994; 17:761-4.

Dr. Nilasena's work was supported by a VA Ambulatory Care Fellowship, sponsored by the Salt Lake VAMC and the VA Office of Academic Affairs.

The authors would like to acknowledge Dr. Barry Stults, Dr. John Williamson, and Iona Thraen for assistance with DM guideline revisions, Dr. Charles Turner for helpful advise on study design and data analysis, Dr. Homer Warner for his inspiration and support as supervisory committee chair, and the clinic and medical record staffs at the VAMC and UUMC for their assistance in the undertaking of this project.